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ADDRESS OF PRESIDENT ROOSEVELT AT COMMENCEMENT EXERCISES OF THE UNIVERSITY OF CALIFORNIA, MAY 14, 1903.

President Wheeler; Fellow-Members of the University:

Last night in speaking to one of my new friends in California he told me that he thought enough had been said to me about the fruits and flowers; that enough had been said to me about California being an Eden, and that he wished I would pay some attention to Adam as well. Much though I have been interested in the wonderful physical beauty of this wonderful State, I have been infinitely more interested in its citizenship, and perhaps most in its citizenship in the making.

When I come to the University of California and am greeted by its President I am greeted by an old and valued friend, a friend whom I have not merely known socially but upon whom while I was Governor of New York I leaned often for advice and assistance in the problems with which I had to deal. And when he accepted your offer I grudged him to you; and it was not until I came here, not until I have seen you, that I have been fully reconciled to the loss. But now I am, for I can conceive of no happier life for any man to lead to whom life means what it should mean, than the life of the President of this great University.

This same friend last night suggested to me a thought that I intend to work out in speaking to you today. We

were talking over the University of California and from that we spoke of the general educational system of our country. Facts tend to become commonplace and we tend to lose sight of their importance when once they become ingrained into the life of the nation. Although we talk a good deal about what the widespread education of this country means, I question if many of us deeply consider its meaning. From the lowest grade of the public school to the highest form of university training, education in this country is at the disposal of every man, every woman, who chooses to work for and obtain it. The state has done much, very much; witness this University. Private benefaction has done much, very much; witness also this University. And each one of us who has obtained an education has obtained something for which he or she has not personally paid. No matter what the school, what the university, every American who has a school training, a university training, has obtained something given to him outright by the state, or given to him by those dead or those living who were able to make provision for that training because of the protection of the state, because of existence within its borders. Each one of us then who has an education, school or college, has obtained something from the community at large for which he or she has not paid, and no self-respecting man or woman is content to rest permanently under such an obligation. Where the state has bestowed education the man who accepts it must be content to accept it merely as a charity unless he returns to the state in full in the shape of good citizenship. I do not ask of you, men and women here today, good citizenship as a favor to the state. I demand it of you as a right, and hold you recreant to your duty if you fail to give it.

Here you are in this University, in this State, with its wonderful climate which is going to permit to people of a northern stock for the first time in the history of that northern stock to gain education under physical circumstances, under physical surroundings, somewhat akin to

those which surrounded the early Greeks. Here you have all those advantages and you are not to be excused if you do not show in tangible fashion your appreciation of them and your power to give practical effect to that appreciation. From all our citizens we have a right to expect good citizenship; but most of all from those who have received most, most of all from those who have had the training of body, of mind, of soul, which comes from association in and with a great university. To those to whom much has been given we have Biblical authority to expect and demand much in return; and the most that can be given to any man is education. I expect and demand in the name of the nation much more from you who have had training of the mind than from those of mere wealth—to that man much has been given too and much will be expected from him, and ought to be—but not as much as from you because your possession is more valuable than his. If you envy him I think poorly of you. Envy is merely the meanest form of admiration, and a man who envies another admits thereby his own inferiority. We have a right to expect from the college-bred man, the college-bred woman, a proper sense of proportion, a proper sense of perspective, which will enable him or her to see things in their right relation one to another, and when thus seen while wealth will have a proper place, a just place, as an instrument for achieving happiness and power, for conferring happiness and power, it will not stand as high as much else in our national life. I ask you to take that not as a conventional statement from the university platform, but to test it by thinking of the men whom you admire in our past history and seeing what are the qualities which have made you admire them, what are the services they have rendered. For as President Wheeler said today it is true now as it ever has been true that the greatest good fortune, the greatest honor, that can befall any man is that he shall serve, that he shall serve the nation, serve his people, serve mankind; and looking back in history the names that come up before us, the names to which we turn,

the names of the men of our own people which stand as shining honor marks in our annals, the names of those men typifying qualities which rightly we should hold in reverence, are the names of the statesmen, of the soldiers, of the poets, of the architects of our material prosperity also,—but only also.

Of recent years I have been thrown in contact with a number of college graduates doing good service to the country and as I wish to make it perfectly evident what I mean by the kind of service which I should hope to have from you and which it seems to me worth while to render, I want to say just a word about two college graduates who have during the last five years rendered, and are now rendering, such services: Governor Taft in the Philippines, and Brigadier-General Leonard Wood, lately Governor of Cuba. When we acquired the Philippines and took possession for the time being of Cuba to train its people in citizenship, we assumed heavy responsibilities; so heavy that some very excellent people thought we ought to shirk them. I hold that a great and masterful people forfeits its title to greatness if it shirks any work because that work is difficult and responsible. The difficulty and responsibility impose upon us the high duty of doing the work well, but they in no way excuse us for refusing to do it. We had to do the work and the question came of the choice of instruments in doing it. The most important and most difficult task after the establishment of order by the army in the Philippines was the establishment of civil government therein; and second only in importance to that came the administration of Cuba, during the three years and over that elapsed before we were able to turn its government over to its own people and start it as a free republic. When tasks are all-important the most important factor in doing them right is the choice of the agents; and among the many debts of gratitude which this nation owes to President McKinley no debt is greater than the debt we owe him for the choice of his instruments, such a choice as that of Taft,

such a choice as that of Wood. We sent Taft to the Philippines; we sent Wood to Cuba; both of them, as tested by the standard of our commercial life, poor men; each man with little more than his salary to keep himself and his family; each man to handle millions upon millions of dollars, to have the power by mere conniving at what was improper to acquire untold wealth—and sent them knowing that we did not ever have to consider whether such opportunities would be temptations toward them; sent them knowing that they had the ideals of the American college-bred man, and that therefore we did not have to consider the chance of a possible temptation appealing to them.

Taft has gone to the Philippines to stay there; not only forfeiting thereby the certainty of brilliant rise in his profession on the bench or at the bar here if he had stayed, but at imminent risk to his own health, because he felt that his duty as an American made him go; that as President McKinley told me of him, he had been drafted into the service of the country and he could not honorably refuse. We have seen in consequence the Philippine Islands administered by the American official who is at the head of the government and by his colleagues in the interest primarily of their people, and seeking to obtain for the United States, for the dominant race, that spent its blood and its treasure in making firm and stable the government of those Islands—seeking to obtain for that dominant race only the reward that comes from the consciousness of duty well done. Under Taft, by and through his efforts, not only have peace and material well-being come to those Islands to a degree never before known in their recorded history, and to a degree infinitely greater than had ever been dreamed possible by those who knew them best, but more than that, a greater measure of self-government has been given to them than has now come to any other Asiatic people under alien rule, than to any other Asiatic people under their own rulers, save Japan alone. That is an achievement of the past five years which I hold to be absolutely unparalleled in history;

and when the debit and credit side of our national life is finally made up a long stroke shall be put to the credit side of what has been done in the Philippines under Taft and his associates.

In the same way Leonard Wood worked in Cuba. Put down there to do an absolutely new task, to take a people of a different race, a different speech, a different creed, a people just emerging from the hideous welter of a cruel war beyond what we in this fortunate country can readily conceive—to take a people down in the depths of poverty, in the depths of misery, just recovering from suffering which makes one shudder to think of, a people untrained utterly and absolutely in self-government and fit them for it; and he did it. For three years he worked. He established a school system as good as the best that we have in any of our states. He cleaned cities which had never been cleaned in their existence before. He secured absolute safety for life and property. He did the kind of governmental work which should be the undying honor of our people forever. And he came home to what? He came home to be thanked by a few, to be attacked by others—not to their credit—and to have as his real reward the sense that though his work had been done at pecuniary sacrifice to him, that though the demands upon him had been such as to eat into his private means, yet he had willingly and well done his duty as an American citizen and reflected honor, fresh honor, upon the uniform of the United States army.

I have chosen Taft and Wood simply as examples, simply as instances of what other men by the hundred have done, Americans who have graduated from no college, Americans who have graduated from all our different colleges, and especially by practically all those Americans who have graduated from the two great typical American institutions of learning—West Point and Annapolis. Taft and Wood and their fellows are spending or have spent the best years of their prime in doing a work which means to

them pecuniary loss, at the best a bare livelihood while they are doing it, and are doing it gladly because they realize the truth that the highest privilege that can be given to any man is the privilege of serving his country, his fellow Americans. As I am speaking to an audience with proper ideals, when I say that Taft and Wood have done all this service to their pecuniary loss, I am holding them up not for pity—for envy. The least mean thought of envy is the envy of the man who does such work as they do. Everyone here, every man, every woman, should feel it incumbent upon him or her to welcome with joy the chance to render service to the country, service to our people at large, and to accept the rendering of the service as in itself ample repayment therefor. Do not misunderstand me. The average man, the average woman, must earn his or her living in one way or another, and I most emphatically do not advise anyone to decline to do the humdrum, every-day duties, because there may come a chance for the display of heroism. Let me just tell you one anecdote—then I am through. When I raised my regiment prior to going to Cuba, we had recruits from every portion of the country in it, some of them without a very clear idea of what was ahead of them. I had one young man, full of enthusiasm, who about the third day came to me and said: "Colonel, I came down here to fight for my country; they have treated me like a serf; they have put me to burying a dead horse." At that moment his captain, who was a large man from New Mexico and not wholly sympathetic, came up and explained to him that he would go right on burying that dead horse and that the next task ahead of him was digging kitchen sinks; and if he did all that well we would attend to the hero business later.

I ask of you the straightforward, earnest performance of duty in all the little things that come up day by day in business, in domestic life, in every way, and then when the opportunity comes if you have thus done your duty in the lesser things, I know you will rise level to the heroic needs.

OPENING ADDRESS.*

BENJ. IDE WHEELER.

As we stand here at the opening of another year it is properly of interest to review the more important changes which distinguish the University of today from that of a year ago. An addition has been made to the University Library Building which nearly doubles its book-storing capacity and provides five good seminary rooms. During the year we have been able to expend nearly $35,000 for the purchase of new books and periodicals, an amount about ten times that which was available four years ago for the same purpose. One-half of this money, in round numbers, was made up of private gifts. Of these the chief are that of Mr. Claus Spreckels for a library of History and Political Science, and those of Mrs. William H. Crocker for the Departments of Physiology and of Mediaeval History.

An enlargement of the Chemical Laboratory has among other things provided room for the new work in Physical Chemistry under charge of Dr. Cottrell, who joined our force in January last. The equipment of the laboratory has also been considerably increased.

The new Faculty Club House has provided a much appreciated meeting-place for the members of the instructing force and sensibly relieved the congestion, and we hope improved the digestion, in the rooms of the Dining Associa-

*Address delivered by President Wheeler at the opening University Meeting of the academic year, August 17, 1903.

tion. The two institutions are still served from a common kitchen in which a fine great range, the gift of Mrs. Hearst, holds the seat of honor.

The women of the University have now a meeting place and club house in the admirably equipped Hearst Hall, the Faculty have theirs in the Faculty Club House; the next thing should be a place of assemblage and rendezvous for the men. There is at present no place where a man can eat his lunch or leave his coat and books, or sit down to read in an interim hour on a rainy day, no place the men can call their own, no place where the seniors can meet for a sociable singing on a chilly night.

Hard by on the borders of the Hillegass Tract has been erected through the generosity of Mr. Rudolph Spreckels the new Physiological Laboratory, finely equipped by Mr. Spreckels and Dr. Herzstein and constituting in space, arrangement and outfit the most practically serviceable physiological laboratory in the country and perhaps in the world. The best part of its equipment is created by the presence of Professor Jacques Loeb and his corps of five trained aides. The building will be dedicated with an address by Professor Ostwald of Leipzig.

The Mining Building which Mrs. Hearst is building in memory of her husband for the use of the University is now rising rapidly after a long halt occasioned by the famine in steel, and promises now to be ready for occupancy one year from this time. We shall then have a Mining Building with which none anywhere will assume to vie.

The new Theatre is fast approaching completion. It will be a structure as unique in design as it will be uniquely beautiful and directly useful. On the 24th of September it will be dedicated, and the exercises of dedication will be graced by the presentation of the most graceful of the extant products of the old Greek comic stage, the immortal "Birds" of Aristophanes. We expect the giver of the building, Mr. William R. Hearst, to be present on that occasion.

Through the generosity of our State the sum of $250,000

has been provided for a building — we commonly speak of it as California Hall — the foundations of which are shortly to be laid in the open campus west of North Hall and south of the enclosed tennis court. The plans are now nearly completed.

Of the new fields of study opened with this year the most significant is the Department of Architecture with Professor John Galen Howard at its head.

The Department of Agriculture is strengthened by the addition of four new positions, among them, that of Assistant Professor R. E. Smith, Plant Pathologist, and of Professor Jaffa, who returns from his year of study abroad.

A readjustment of the force in Civil Engineering which it is expected will result in greatly strengthening that department brings to us Associate Professor Derleth from the University of Colorado (earlier of Columbia), and Assistant Professor Prouty, four years ago member of the department and since then engaged in practical railroad work.

A change in the method of school examination is signalized by the appointment of Dr. Scott Thomas as Examiner of Schools. In his capacity as Assistant Professor of Education he will in the second half-year conduct classes at the University in connection with the Department of Education.

We welcome back to his chair in History Professor Bernard Moses after three years of eminent public service as Commissioner to the Philippine Islands. At the next University Meeting he will have his message to present to us.

Professors Clapp and Haskell and Senger return from their year's leave of absence, which has been spent in interesting experiences and enlivening studies in Europe, and Professor Jones returns from a half-year's absence. We give them all our cordial welcome home.

Dr. Hart, after three years study at Harvard, returns to the Department of English and Professor Rieber, who comes

this year to our Department of Philosophy, is really one of our own returning home, and so it is to them too, Welcome home!

The Department of University Extension, if it prove in future years as successful as it has been in Professor Stephens's hands the past year, will require a constant increase in its force of lecturers. This year one regular lecturer has been added in the person of Mr. G. M. Borden, who will act also as Secretary of the Department.

I am sure the teaching force and the equipment of the University were never in better condition to meet the work of a year; are you, students — fellow-students — are you ready for your part; are you ready to join with us in making this the best year of all the years, the best for the upbuilding of womanhood and manhood in yourselves, the best for the upbuilding of our beloved state and the establishment of truth among men?—joined hand in hand we can do all things, sundered we beat the air.

If you should have opportunity to read a recent book entitled, "A Self-made Merchant's Letters to his Son," you will find therein much good counsel applicable to real life, and you can well afford to take to heart the merchant's words to his son as he is entering college: "You'll find that education's about the only thing lying around here loose in this world, and that it's about the only thing a fellow can have as much of as he's willing to haul away. Everything else is screwed down tight and the screw-driver lost." This says in other words that at a university you get what you take — not what is forced upon you — not what forces itself upon you. What is forced upon you and crammed into you will not digest — and the last state of that man shall be worse than the first. If you sit around waiting for the good influences to soak in through the pores you will leave here only feebler and lazier than you came. If you drift along with the crowd, and do what other people do and what other people tell you to do and what seems in general the proper thing to do, you will either be

a nonentity from beginning to end, or perhaps enjoy a certain fictitious popularity at the start which will ripen into contempt at the end. You are now at an age, you are now at a place, where you must do for yourselves. No one can afford to order his life according either to criticism or compliment. Only this, however, when the former rises into abuse, you know of a surety you have been doing your duty, when the latter rises into flattery, you know you are in danger. You may ask advice and listen to it, but after you have assembled the data, you must decide for yourself; you *must*, if you are going to be anybody, if you are going to be an anybody with character. Every man of decided success in life will tell you that in this or that emergency of his life out of which has come for him the greatest achievement, he has decided alone and for himself in the face of tradition, of ease, and of commonplace advice. And here I am not for a moment advising you to spurn advice, but on the contrary to hear it as for your lives, and to apply it in full consciousness that the responsibility is your own.

These general considerations have now at last brought me to my text: the university is a school of character. All the various theories of it conspire in this definition of it; all the varied personal experiences of its workings and effects conspire in this description of it.

It deals with each individual as a living organism. It undertakes to secure for a plant the conditions of healthy growth, not to paint leaves and flowers on a bundle of fagots. Whatever permanent good comes of its influence will come out of the individual himself. Varnish and veneer will crack and peel in the heat of the first stress.

It addresses itself to the good there is in a man and tries to bring that out into control over the bad there is in him, to develop the implicit good into prominence over the implicit bad, the implicit spiritual over the implicit bestial, the implicit reasonable over the implicit mechanical.

It is as an inspirer and guide that the university chiefly

acts in the development of character. It is no purveyor of information. Information does not make character. Knowledge of mechanics and of the strength of materials only makes a burglar a more dangerous member of society. The typical form of university study is represented in the work of the laboratory and the seminary when pupil and teacher study together, the pupil receiving from the teacher only the method of the work and the inspiration thereto. The spirit underlying the class-room work must be the same. So far as any sound result is to come from it, it must and will be the same, for all that counts is what the pupil by actual volition himself reaches for and takes.

The work of the class-room and laboratory alike is the unfolding of truth, and truth is always new truth each time it is apprehended by each living mind. Here is a condition where date of publication and questions of priority make no matter. For each man there is the outpost of the known and there he must stand, alert to see, ready to push on, sane to judge of what he sees. The liberating and uplifting power of the truth in each man's life rests in his attitude and behavior on his own border-line. It is by what he sees himself, and by the manner of its use that he will gain control of his world and control of himself and rise into character.

Your teachers are seated in no chairs of authority. The University itself teaches not on authority. There *is* no authority but the self-convincing power of truth itself. And if ye would be freemen, it is written whereby ye should be free: the truth—the truth as each one has the open eye, the clear will, the healthy soul to apprehend it and make it his — the truth shall make you free and make you strong.

SOME DEMANDS OF THE NEW INDUSTRIAL ORDER ON THE UNIVERSITIES.*

ADOLPH C. MILLER.

In seeking a theme for this occasion, I have tried to choose one that should be of an educational character, and yet one that should touch the wider and larger public interest in the purposes and activities of the higher institutions of learning. Our colleges and universities—hardly less, those that have been reared on a private foundation, than those that have been created and supported at public expense—are *public* institutions in a more complete sense than those of any other country. In the end they are—all of them—dependent for their prosperity on public approval, no one of them can hope to have a solid success without it, and that approval in the case of any given institution springs out of the faith the public has that that institution is sending out men and women capable of taking a useful position in the world, and of doing good and needed work. In this sense, I repeat, all of our successful colleges and universities are public institutions. The work that the modern world requires is of a sufficiently varied character to permit of a considerable range of variety in the type of institution best suited to different local conditions, but, whatever the nature of the work, it is by its ability to train

*An address delivered at the Annual Commencement Exercises of Nevada State University, June 3, 1903.

men and women fit for service, that the public will test the efficiency of a university and give it favor.

It is under the pressure of this sort of necessity that our institutions of learning have developed many of their most striking characteristics. Colleges and universities are by their very nature conservative, slow to yield their inherited ideas and traditions, even to the calls of an advancing civilization. (Indeed, a moderate conservatism has rightly been held to be one of their best traits). But the American university is flexible and plastic compared with the English college or the French university. The constitution of an English college is hard, rigid and uncompromising, not easily moulded to new ideas or new necessities. And so it happens that the Oxford of today is, perhaps, more like the Oxford of the sixteenth century than the Harvard of to-day is like the Harvard of the fifties. It would be hardly an exaggeration to say that the typically active American university makes more history—observe, I do not say more progress!—in a generation—not to say a decade—than an Oxford college can show for a century. What is true of us as a nation in the field of industrial enterprise, is coming to be true of us, also, in the field of education. To an English workmen or engineer, the fact that a thing has been done thus or thus in the past is one of the best of reasons why it should continue to be done in much the same way in the present. To an American, the same circumstance is one of the best reasons for *not* doing it in the same way any longer. As a nation, we feel very little concern for experience, we are temperamentally impatient of the past whenever it offers a bar to adventure in the present. For us to be wise means almost to do otherwise—*semper studiosi rerum novarum.*

No doubt our light-hearted indifference to experience has cost us some disappointing experiments and wasteful failures. But, on the whole, it has been an element of strength. If it can be said that the Englishman has been spared many blunders because of his stupidity, it can also be said that our readiness for adventure, our eagerness for

experiment, our acquiescence in change, and our quick adaptation to a new environment of our own making, have been the secrets of our most solid achievements and startling successes in the field of industry. And—what I am especially concerned to point out now—this readiness for change, which has been fired to a passion in the field of business enterprise, has also touched the imagination of our educational leaders. They have shown a willingness to experiment with the educational system, high as well as low, in the confidence that though, now and then, here and there, mistakes might be made, nevertheless, in the end, there would come out of it, a preponderance of the good over the evil that would easily pay the costs of the failures and leave us stronger for our work. Whether this faith is justified by the records I cannot stop to examine. My personal opinion is that it is. I allude to it merely because it designates and explains, in part at least, what I regard as the most signal feature of our educational organization—its responsiveness to new ideas and larger demands. And so far as the modern world is one mainly colored, and ordered, and motived by industrial facts and forces, I want especially to consider some of the demands made by the new industrial order on the universities. No one who would number himself among an audience of this character can doubt that the universities of to-day are a most important part of the enginery of social control—a part gigantic in its power when wisely guided. How to use it so as to make it more effective in serving the needs and shaping the destinies of society, is always a worthy theme.

The development of its material resources has been the chosen task of the nation, especially since the close of the Civil War. The best energy of the people has gone to laying deep the foundations of economic power. A continent has been subdued to the uses of man, and our success in the achievement we owe mainly to the skill, and inventiveness, and daring, of our leaders. Never did business enterprise anywhere press science and skill into its service as in this

country, during the past generation. We have travelled a thousand years since the Civil War, so profound has been the transformation wrought in the mechanism of production in that time. New appliances and agencies have succeeded one another with a rapidity that has been unsettling. The period has had all the marks of a revolution—a second industrial revolution; and its course is not yet run. Much as the nineteenth century owes to applied science, we confidently expect the debt of the new century to be larger. Each year sees a quickened pace in mechanical invention and chemical discovery. The dependence of industrial progress on the advance of science could not be more complete. The demand for the man of skill, resourcefulness, and originality has become of growing urgency each year.

An economic situation of this kind could not fail to react on educational ideas and methods, nor were the leaders of education slow to grasp its meaning. Undeterred by the prophets of a different order, they have gone ahead and devoted a considerable share of the educational resources of the country to the development of technical training. They could not have done otherwise without a plain violation of the faith the public put in them. And, consequently, of the many features that have marked American university development since the Civil War, none is more noticeable than the multiplication of facilities for technical training. We have come to regard the school of applied science as one of the handmaids of industry, and we accept it as one of the indispensable functions of an American university, that it should provide facilities for equipping men to pursue each important calling according to the best scientific methods. We do not think such instruction is in derogation of the dignity of a university. On the contrary we think it is one of the ways of linking the university to the chariot of progress.

That there are some very real dangers to be feared from a too vehement insistence on the value of the technical and the professional spirit in university education I do not deny.

But I am not now so much concerned to discuss the limitations and dangers of this view of education as I am to point out some of its useful implications. I shall have something to say later on the question, whether the training of the capacities that make the expert represents the whole, or even the most urgent, service to which an American university can give itself. It is enough, for my present purpose, to point out that the spirit of professionalism is, for the time being, the reigning influence in shaping university policy, and to ask, in a spirit of accord with this view, whether there is not a demand for the extension of the spirit and method of technical education into new fields, and specifically into the field of business enterprise.

In some of its aspects, this is a very old question, in others, it is new, and the discussion timely. I suppose no topic has been discussed on commencement platforms more often than that of the value of a college education to the young man who hopes to find a career in what one generally understands by business. College graduates—no less those who have not, than those who have, had experience in business—are pretty generally willing to give testimony in behalf of the college. But the persistence of the discussion in the face of such testimony is, I think, good reason for suspecting that the public at large is still unconvinced of the soundness of the conventional academic view on this question. Successful business men who have not had a college training are frequently heard to declare against it. Mr. Carnegie, whom a respectable portion of the general public seems much inclined to accept as an authority on education, as well as upon steel and sociology, said a few years ago, that he did not know any successful business men who were college graduates. But such assertions do not settle the question one way or the other; and I should not have thought it worth while to raise the question afresh were there not another aspect of it that seems worth emphasizing. In any case, it seems useless to lay down hard and fast rules, or to draw a sharp line in business life

between the men who have had a business education to begin with and those who have not.

But the phrase "college education" is itself vague—altogether too vague to describe the matter for discussion. It has lost the definiteness of meaning possessed fifty, or even twenty, years ago. The modern university stands committed to no single type of culture; it includes within itself a variety of disciplines, undertaken with different intentions. Between a college of liberal arts and a college of practical arts, like mechanics or agriculture, there are such wide differences of aim, and even of methods, that they cannot be subsumed under the same head in discussing the advantages of college education, and disposed of in the same judgment. The one is professedly a special preparation for a definite industrial service, the other proposes to itself no definite career unless it be that of right thinking and right living. Should it be occasion for surprise, therefore, if these two types of college education be found to meet the test of practicality in different degrees? That the technical college needs no defense on this score is too evident to require argument. That there is, however, good reason for doubting the practical value of the ordinary college course, cannot be questioned. I have no unalterable conviction on this point, but I strongly incline to the opinion of those who deny that the conventional classical, literary, or humanistic training is of momentous use to the man who is going to take his chances in business. The four years' study of Greek, Latin, mathematics, and philosophy do not seem a consummate preparation for the work of market-place, manager's office, or director's room. Those studies do much, no doubt, to cultivate the analytical and reflective faculties, and so far, the time given to them is not all lost. But they cannot do as much by a tithe to ripen the habits of observation and of attention to details, the sense of relative importance, or to train the judgment to accuracy, as four years in the formative period of youth given to incessant contact with the fierce and uncompro-

mising realities of business life. College life, of the type now in question, is, under the finest of conditions, a sheltered existence; it is not its principal purpose to train those faculties or harden those fibers which are most prized in the practice of business. Let me not be misunderstood. I set a very high estimate on just this sort of culture against which I seem to be arguing. I regard it as one of the most precious possessions in life. But I recognize that its eternal claims to our gratitude are derived from ends and ideals not ordinarily accepted as tests of business fitness. When we are seeking the relation of college education to success in business, we do not solve the problem by insisting that life is more than livelihood, that the man should be more than his calling. When all this is admitted the problem is still upon us.

The problem then which at the present stage of public opinion it seems profitable to discuss is not whether college education of the traditional kind may be of value as a preparation for business, but whether it is possible to arrange a course of university training that shall prove an asset of distinct and certain value—a course that shall bear much the same relation to business as existing courses in law, medicine, or engineering do to their several professions. Perhaps the analogy would be even more suggestively stated if the training of business men were likened to the pre-medical and pre-legal courses that have been established in recent years by some universities. For these courses seem to be off-spring of the same necessity that now bespeaks our friendly offices for its last-born. These courses aim at a considerable degree of special preparation for a given profession, without intentionally sacrificing anything of what is cherished as essential in all college education worthy of the name—the quickening of the intellectual and spiritual insight of the student and the widening and elevating of his sympathies.

This is the question, briefly stated,—a question that is deriving interest and timeliness from the importance and

dignity that the business career is coming to hold in the esteem of the public. Whatever prejudice may still linger in the unemancipated public mind of old-world communities, with their traditions of a feudal culture, the truer and more liberal sentiment of the new world regards business as affording opportunity for a career good enough and big enough for any man. It is into the field of business enterprise that the best talent of the nation is going, and its achievements in the realm of business organization are among the greatest and most characteristic works of our national genius. It is in the ranks of the merchants, manufacturers, inventors and organizers—the captains of industry—that we must look if we would find the "Plutarch's men" of our day.

With the business man bulking thus large in the American imagination, it is natural that the demand should be made—and made with strenuous insistence—that the universities should undertake to do something more, and more specific, to equip young men for the business life than they have done hitherto. And with characteristic zeal to meet this new demand, we find a number among our leading universities that have already begun the institution of Colleges or Schools of Commerce. To mention only the names of the pioneers in this movement, we have the Universities of Pennsylvania, Chicago, California, Dartmouth, Illinois, Michigan and Wisconsin. The College of Commerce is bound, sooner or later, to take its honorable and equal position in the sisterhood of colleges that makes the American university, wherever the demands of the new industrial order are heeded. And to the young men of the rising generation will be given opportunity to fit themselves for service, on a scale commensurate with the magnitude and complexity of the expanding business of the modern world. And the American university will, in a fresh sense, become a momentous factor, not only in the success of individuals, but also in the prosperity of the nation.

Here, however, it is necessary to pause to notice an

objection. Many who will agree with what has thus far been said, many who will agree that a properly organized curriculum can do much to train the higher business faculties, will yet doubt whether the undertaking is worth while, in the face of what seems to them the certain and inevitable drift in the business world of the twentieth century. The conviction has taken hold of many minds, not easily given to alarm, that the range of independent opportunities in the business world is being seriously narrowed by the changes that have ushered in the new industrial order. It is not necessary to recall with any fulness of detail the essential features of the new system of industrial control. Its merits and its defects have been pretty thoroughly canvassed in connection with the recent discussion of the Trust Problem. I believe it is admitted by most well-informed persons that the principle of coöperative capitalism, which has given us those great associations of capital that are popularly called *trusts*, has been productive of certain good in the sphere of economic production. The prodigious strides that American industry has taken in recent years are largely due to the superior efficiency of the new capitalism. By limiting more and more the friction and wastes of the competitive system and by securing, in addition, the enormous advantages of centralized production on a vast scale, the capitalistic combinations have effected a saving of industrial energy of almost incalculable extent. This, I say, is very generally admitted. But the trusts have done all this, we are incessantly warned, at the cost of a real and dangerous abridgement of opportunity for the average man of to-day. And, inasmuch as all the signs of the times point to a still wider application of the principle of coöperation in the future, a still further shrinkage of opportunity for making a living and doing something in the world of business, seems manifest destiny. For the young man without wealth or inherited position the outlook under the coming *régime* of economic imperialism is dark and cheerless. We are fast in the tentacles of the octopus and the days of

individual opportunity are gone. Thus speaks the prophet of the order that is passing.

Let me say at once that I do not share this pessimistic view of the outlook afforded by the industrial order that is coming, nor do I see any reason for believing that the man of trained capacity will be less of a figure in the future than he has been in the past. This sort of economic pessimism rests on a very shallow understanding of the essential factors of our business system. It can not be too often repeated to the young men of to-day, that the modern world demands the highest type of efficiency of its leaders and workers in every department of activity, as the indispensable condition of success. This is not only as true in business as in any other field, it is even truer. In the modern sense, efficiency means not simply power—power in general —but power to do something—something in particular—and do it as well as it can be done. In this sense the man of excellence is still the moving force in the world, and the young man who has possessed himself of the capacities that make for excellence and leadership, the man who has learned how to make expert application of his developed force and ability, in the service of society, need never fear that he will be long without an opportunity. The best asset,—far better than a liberal bank account,—that the young man who believes in himself and in his times can take with him into the world, is a well-trained capacity. It will pay bigger interest than the so-called "safe investment" and steadier dividends than the so-called "big thing." It is the real preferred stock of modern industry—the one security whose value cannot be destroyed by bankruptcy, foreclosure, reorganization or consolidation.

In emphasizing thus the part played by expert capacity in the modern business system, I may seem to be neglecting the important rôle that belongs to capital. I am not insensible of the close dependence of modern industry on capital, but I am sure we are too prone to exaggerate its importance to the individual. It is a mistake, made with especial

frequency by the man who wants capital and hasn't it, to think it the decisive factor in business success. To him capital seems to hold the right of way to the best opportunities the world affords, and he views the concentration of capital, that the industrial consolidations are effecting, as the complete destruction of opportunity for the many. It is certainly true that capital gives power of industrial control: whoever possesses capital has it in his power to set industry in motion. This is much but it is not all. Mere money, capital—the lifeless tools of production—is in itself as dead and barren as the unwatered desert. Capital is not self-directing, nor is the owner of capital always guided by an unerring instinct. It is as true in business as any where else that "a fool and his money are soon parted." Capital needs the touch of human service to quicken it to useful life, and the vaster and more complex the organization of industry becomes, the more intimate this dependence will be. It is true that the big combination can, in virtue of its massive capital, do many things that a smaller concern could not attempt, but the big combination absolutely demands for its success the highest order of personal ability. The history of broken trusts shows too plainly that there is no magic in mere combination that invariably brings success. What is it that makes some serious students of economic evolution regard the industrial tenure of the trusts as at best precarious? The doubt, namely, whether there is enough first-rate ability in the country to manage the affairs of these gigantic concerns. "The mere work of centralized administration," says President Hadley, "puts a tax upon the brains of men who are accustomed to a smaller range of duties that very few find themselves able to bear."

Just as Manila and Santiago showed that the wonderful improvements of naval ordnance had not displaced the man behind the gun, so the victories that our men of industry are winning for us in the struggle for industrial supremacy, show that the man is still superior to the dollar. We can

not all expect to be Morgans or Carnegies, but there is room, not only at the top, but all the way through the hierarchy of industry, wherever skill and capacity are requisities for efficient service. The kind of places may be different from those offered under the old conditions, some readjustment of ideas and expectations will be required of most of us, but, such as the new order is, it will afford abundant opportunity to men of disciplined character and intelligence—opportunity enough to satisfy any ambition and furnish outlet for the most restless energy. But of one thing we may be sure: whatever we may think of it, the new order is here to stay; and the first business of the young men of to-day is to recognize it and learn to adjust themselves to it. We shall learn from experience how to control the new system wherever that may be necessary in the interest of society, but we shall not abandon it. We will never commit the folly of turning back from this new, compact, scientific organization of industry to the warfare and wastefulness of the old competitive system. Each of us should, therefore, learn to take his place in the new order, in the faith that what is good for the community cannot fail to be good also for him.

Under these circumstances the educational agencies whose function it is to train the capacities that make for expert service, cannot help finding an ampler field than ever before. And the School or College of Commerce is certainly to be a part of those agencies in the future. So far, the demand made by the new industrial order on the universities seems clear. But this is not all, we may not stop here.

What I have said thus far I have meant to be in strict conformity with the technical ideal of education—not because I am in complete sympathy with that ideal, but because it must be recognized as the most distinctive and the strongest of the influences that are shaping educational policy in this country to-day. More than that, I have tried to take a somewhat personal view of the situation, dwelling

on those aspects of it which appeal with particular force to the young man. He is concerned to know what impending changes in the world mean to him personally. And it is with his difficulties and problems largely in mind, that I have spoken. But I should be untrue to my deepest convictions of the supreme need of universities in our country and in our time, if I professed to rest content with the notion of "getting on in the world" as the test of effective college education. The traditional American idea has always rightly regarded the college as more than a place where young men are taught to play the bread-and-butter game successfully. It is not for this alone, nor for this primarily, that public and private munificence has shown such favor to the universities. The connection between public welfare and the higher education that has inspired the founders and builders of our universities lies deeper, and implies far greater capacities for public service than could be furnished by any system of technical instruction, however effective. Let it never be forgotten that the profoundest need the country has for college-trained men comes from a different source. So long as America shall continue to be a community of self-governing freemen, so long as public sentiment must be relied on as the best and strongest force in government, so long as the guidance of the destinies of the country is the share of the citizen, so long the building of character, of disciplined character, the character that befits the American citizen, must be the first and deepest concern of the American university.

If the history of the nineteenth century teaches one lesson that the student of public welfare should take to heart, it is the futility, in a democratic republic, of trusting to enactments and prohibitions to secure the ends of social justice and an upright public order. Each step in the development of our recent civilization has made it clearer that it is by character alone that social salvation will come. A nation can no more live a healthy life without a conscience than can an individual, and it is only as we succeed

in bringing to the tasks of government and of business the same standards of right and wrong that we apply in our personal relations, that we can hope to maintain in its integrity the polity builded for us by our fathers. That we as a community have suffered a decay of conscience in the past forty or fifty years is the opinion of many competent observers; that our standards of political and commercial decency have failed to improve as rapidly as our standards of personal conduct, no one will deny. It is still too much our habit to regard politics as business, and business as a game, in which everything is legitimate that is allowed by the rules. The disposition to take shelter from responsibility in these affairs behind a code that is admittedly defective threatens to become a national vice.

If these tendencies were a danger under the simpler economic constitution of the past, they are a menace of multiplied force under the new order; for traditional safeguards are losing much of their efficiency, in the region of business at least. Time was when competition gave a substantial measure of protection to workman and consumer, and insured conformity to a certain level of commercial morality. But the times have changed; and, in place of a system of diffused management, we have centralized control of industry, with its far stronger temptations to abuse and excess. Under such circumstances, private control of industry can be compatible with the public interest only if exercised with a sense of the public obligation which such power entails. When business attains the dimensions that many of the consolidated enterprises have in recent years, it takes on a public character, and the public has a right to invest its management with the qualities and limitations of a trust. Curiously enough, the name which, under the earlier exigencies of legal invention, was applied to the great combinations of capital, is significant of the spirit in which the business of the new era will have to be conducted. It is nothing less than the spirit of trusteeship—the spirit of consideration for the rights and interests of others; yes,

even more than this, the spirit of a partnership, in which the claims of the public will not be set aside by the declaration "This is my business, I will manage it as I like." We may not disguise from ourselves that the modern business system is on trial, and that its fate will depend largely on the spirit displayed by those in command. There never was a time in the history of the country when it was so important for the great business interests to have the conscience of the nation with them. Many people are growing restive under what they regard as the aggressions and insolence of concentrated wealth and industry. If business is conducted in a narrow, selfish, unyielding spirit, indifferent to the better sentiment of the community, or contemptuous of the equities of others, it is no bold prophecy to say that the early decades of the twentieth century will witness some striking social transformations.

How infinitely important, then, for the salvation of democracy and of free enterprise, for the maintenance of liberty and of opportunity, and for the preservation of our claim to leadership among the nations, that the men who shall stand forth as leaders in industry shall also be leaders in citizenship.

The universities would be untrue to their great historical office as bearers of some of the noblest traditions of the country if they did not hold up this broader and finer view of success and duty, even in the business life. It is the God-given duty of the university to inspire the student with visions of the eternal worth of purity and nobility of character, and unless it does this in every department of its teaching, it fails, and nothing can compensate for the failure. Opportunity and obligation are the twin watchwords of the university, and the university would widen its opportunities in vain if it did not at the same time spread a wider sense of the obligations of wealth, success, opportunity and citizenship throughout the land.

THE RELATION OF BIOLOGY AND THE NEIGHBORING SCIENCES.*

WILHELM OSTWALD.

The event which we celebrate to-day is like the launching of a beautiful ship. The keel has been laid with care; the hull has been made lean and powerful; the engines and propeller are of the newest and best construction. But above all we know that the captain is a man who can guide the ship on the high seas of science with a firm and courageous hand; for we are all aware of the wonderful journeys he has already made, and what fabulous treasures he has thereby gained. We may thus not only wish, but with all the certainty that is possible in human affairs, we may also predict for our splendid ship, a favorable and successful voyage. Only one question remains to be answered: What will the weather be?

Gentlemen, it is a hazardous undertaking to predict the weather of the future. Moreover, our ship is so constructed that it is capable of withstanding storms, and sailing against adverse winds. But since its builders have put into its construction love and hope, it would be a great pleasure to us if we could find adequate grounds for predicting good fortune for our ship in this respect also. Here the wish must

*Address delivered at the Dedication of the Spreckels Physiological Laboratory of the University of California, by Wilhelm Ostwald, Professor of Physical Chemistry at the University of Leipzig. Translated by John Bruce MacCallum.

not influence the judgment; we must test as justly as we can, the conditions of the scientific weather. Perhaps then we may learn in what direction it will be best for the ship to steer, that we may expect a successful journey.

A voyage of scientific discovery of to-day is like a journey taken five hundred years ago for the finding of new lands and seas. Unknown country is on all sides of us; and we shall see new things in whatever direction we pass beyond the boundaries of the known. For there is nothing easier than to make discoveries. He who cannot discover and classify new facts in any branch of natural science after a few weeks, or at most a few months, of industrious work must indeed be ignorant or unskilled. But more than this must be accomplished. New facts in themselves are only an insignificant part of a science. Their main value consists in their relation to what is already known, and to what will be known in the future. The value of new facts is like that of gold. Gold in itself is nothing more than one mineral among thousands; it is of value only in connection with the whole system of commercial values.

Thus if its only duty were to discover new lands, our ship might take any course it chose; it would be only a question of time when new land would be sighted. But it would be a matter also of chance as to what the nature of this land might prove to be. And a sceptical observer would perhaps say: One thing is certain, that we know nothing of this new land, and we should not attempt to make any predictions whatever concerning it.

To this we must answer that it is by no means so impossible to look into the future as we ordinarily think. If we go to the bottom of the matter we find that our whole civilization rests on the fact that we can and do look into the future. Indeed it may be said that the height of any civilization may be directly measured by the thoroughness with which the prophets of this civilization understand their calling, and are able to predict the future. With the exception of eating and drinking, sleeping and kissing,

there are very few things that we do entirely for their own sakes. The countless other things with which we fill out our lives, are done by us only on account of the results we expect from them in the future. This is what we have all done today when we prepared to come to this gathering. If you do not immediately arise and go home it is only because you expect to hear from myself and from others better things than you have heard before.

Naturally the degree of certainty with which one may prophesy is very different under different circumstances. That tomorrow and the next day, and every subsequent twenty-four hours, the sun will rise and set, that every 365 days the change of seasons will recur, we regard as so certain that we do not hesitate to arrange our entire lives on this basis. On the other hand we cannot, at least in Europe, plan a picnic two days in advance, because we do not know whether or not it will rain. That our countries will retain their financial credit for decades and probably for centuries, seems to us so certain that we do not hesitate to base our entire pecuniary existence on this assumption. What the exact condition of the stock markets will be, however, might perhaps be predicted a week ahead by a specially gifted broker; while the majority of men would be entirely unable to make any prediction.

Our ideas of the future consist of an enormously tangled and complicated tissue varying in its nature from the greatest certainty to the most doubtful possibility; and in every one of these various cases we must distinguish the *nature* and the *degree* of probability. We recognize at once that in the struggle for existence, that man will be most efficient who in any field can answer these questions: "What will happen?" and "With what degree of certainty will it happen?" more accurately than his fellow-men. Upon this rests the high veneration and the slavish fear in which races of low development hold their prophets and medicine men. When the Roman Republic undertook a war, it asked the oracles what the outcome of the war

would be; and when in 1870 Bismarck saw that the conflict between Germany and France was unavoidable, he asked Moltke exactly the same question. The oracles predicted from the viscera of a sacrificial animal; Moltke made his prophecy on the ground of his scientific investigations of the military conditions of both countries. Here we have an illustration of the difference between the old and the new civilization; and the word expressing this difference is *science*.

This is in fact the meaning of science; its aim is to make possible a glimpse into the future; and science is the more perfect, the more broadly and surely it allows us to obtain this view. The problem of seeking to find what is the essential thing in science has at some time concerned each one of us; and the answers to this question are very diverse. According to the condition of my knowledge I have found in the course of time that my answers have been very different. Since, however, I have possessed the definition which I have just given you, (which also I find given in Locke) I find myself in a position to solve a great number of different problems more easily and more surely than it was possible for me to do up to that time.

And now, gentlemen, though we have apparently wandered far from the subject of our discourse, we find ourselves again in the midst of it. Science must give us the means of choosing the course which our ship must hold in order to reach with the greatest certainty those unknown lands in which the greatest treasures lie; and when we have reached the sought-for coast, science must show us where we may best cast anchor, and how we may most easily make a landing.

Here we deal truly with a science of sciences. Special problems of mathematics or chemistry must not be solved here. On the contrary we must deal with problems concerning the laws according to which each individual science develops regardless of what it includes. Such a science hardly exists at the present time. There have appeared, it

is true, valuable preliminary studies; the histories of the various sciences have been more or less thoroughly investigated, and *philosophy*, according to the modern definition, comes near to this problem. Still there is lacking for the most part the emphasizing of the history of development in this part of philosophy as well as the discussion of the points of similarity in the histories of the individual sciences. But from both sides there is undoubtedly present a tendency towards the advancement of work in this direction, and we may then look for the establishment of a *biology of the sciences* as a product of the near future.

It is in fact a *biological* problem with which we deal. A rock or a comet has no need of science, for as far as we are able to judge the existence of one of these bodies means nothing to the body itself. We on the other hand, who wish not only to maintain, but also to *improve* our conditions, need science for this purpose; for in order to retain anything, we must know the conditions under which it exists, and in order to improve it we must know how far it is possible to influence these conditions. The surest and broadest knowledge that it is possible for us to have of this is that which we call science.

In fact if we ask what is the most general force which has been active in historical times within our knowledge, and is still active, we recognise that it is the *conquest of all intellectual fields by science*. If we imagine the most primitive conditions in the development of mankind, we see that there is no doubt that *the* individual and *the* race which is finally successful in the struggle for existence is the one that learns to see most clearly into the conditions of the future and thus learns to influence them. There are conditions in which the war of physical force seems to settle the question; but even here we see *skill*, that is, the intellectual or scientific factor, offset a large part of the brute strength, and this factor increases as development advances. The greatest leaders of men have been those who saw most clearly into the future.

Perhaps the objection will be made here that we are accustomed to regard the law-makers and political organizers, and not those who make discoveries or inventions, as the leaders of men; and it is well to account for this apparent contradiction. We apply the same word *law* both to the regularities of the natural processes, and to the arbitrarily influenced actions of mankind. The great thing which the moral and political law-makers have done is *that they have made it possible in certain fields of human actions to make predictions.* Since they did not know the internal causes upon which such actions are dependent, they were obliged to make such external rules or laws in the *juristic* sense. These agree more or less with the unknown psychological and biological laws which are applicable to the phenomena in question. The better they have agreed, the more lasting have been these laws, and the greater and more powerful have been the law-makers. Thus every political and moral organization is dependent on biological conditions; and these fields are evidently those which are destined to be irresistibly conquered by science.

Many of my friends, and indeed those whom I hold personally in very high esteem, have objected very strongly to these views when we have discussed them; and from this I presume that such an objection suggests itself to you also. We are in the habit of connecting with those questions which we have discussed, sensations which are of great value to us, and which we allow to exert a great influence upon us. We regard the political and moral laws with a feeling different from that with which we look upon physical and chemical laws. That which we call *reverence* distinguishes our attitude toward the former. And at the same time there is another great field which seems to be quite apart from the influence of science, and which, nevertheless, forms a great and precious part of our life. This is *art.* Here also more or less vivid sensations become active within us, and lead us to regard art as something which takes us beyond our usual selves, and our every-day

conditions. These sensations of the beautiful, the great, the strong, the eternal, we do not wish to disturb or belittle; and therefore those who see the value and charm of life in those things, protest against their absorption by science, since the calmness and coldness which they ascribe to science are directly opposed to those sensations.

Now in a circle such as this where each one of us has in some way dedicated the better part of his life to science, I do not need to prove that science requires from her children soberness and coldness, so far as criticism is concerned, that is in testing whether work is trustworthy and sound. But no less does science demand of us *reverence*—reverence for the most lasting of all things we know, reverence for *truth*. This reverence arises in us from the knowledge that there is no escape from truth. It matters not how well hidden an error may be, or how perfectly disguised in the garb of truth, we all know that it will nevertheless be detected and banished; and that the inner life of science can drive forth with irresistible force such foreign lodgers. And this expulsion indeed occurs the more quickly and more vigorously, the more intimate the communication is between the false and the true parts of the organism, because in this way the incompatibility sooner becomes evident. In the body of science only those errors which exist in an isolated structure connected with the other parts of science only mechanically, may remain there for a long time like an encapsulated foreign body. There is therefore no better means of testing the truth of a scientific observation than to place it in organic relation with as many other parts of science as possible. We shall have occasion to discuss this matter more thoroughly later.

Why this feeling of reverence does not arise in us with such strength when we think of science, as it does when we think of those things whose greatness and strength we have been accustomed to know from our youth up, is explained by the fact that we do not yet recognize the irresistible power of science as a matter of daily thought

and experience. But when we have once learned to regard science as that which controls our whole existence, then we know that there is nothing more worthy of reverence, and nothing more powerful.

And now what is the position of the beautiful, of art? In the first place it is beyond all doubt that the development of art is dependent upon that of science. If one recalls the history of one of the completed epochs of art such as that of Greek sculpture, it is apparent that from step to step the growth of this art has depended upon increasing knowledge; upon the knowledge not only of the anatomy of the subject, the human body and its movements of expression, but also upon the knowledge of the materials, the marble and the metal. It is evident also that the degree of development of art corresponds with the scientific and technical development. Just as science in general requires for its advancement a constantly increasing knowledge of its subject and its materials, so it is with art. And just as in science a wonderful work may be done by a great genius with limited materials, such as the formulation of Newton's law of gravitation or Mayer's law of energy, so also a great artistic genius may with the limited materials of his time, produce works which will live hundreds and perhaps thousands of years, works such as the dramas of Aeschylus or the Ninth Symphony of Beethoven.

Here too we are struck in a certain sense by the superiority of science; for while we cannot doubt that these products of scientific work will endure as long as civilization is present on the earth, we hesitate to make the same statement concerning the works of art. We cannot deny that in Aeschylus we are aware of a trace of antiquity. In other words there are passages which no longer affect us at the present day as they certainly moved the people of the time of Aeschylus. And in the same way it is not impossible to imagine that a time will come when the Ninth Symphony will affect men no more deeply than a symphony of Haydn now moves us.

This seems to indicate that perhaps art itself is destined to become slowly absorbed by science. I am inclined to believe that this idea will find vigorous and perhaps angry opposition. I emphasize the fact therefore that I personally am indebted to art for many uplifting and beautiful hours. Poetry, music and painting have given me refreshment and new courage, when exhausted by scientific work I have been obliged to lay my tools aside. But I cannot escape the conviction that this is a sign of imperfection, not so much an imperfection of science as of my own self. For science in the sense in which I speak of it today, exists only in its first beginning and the human organism has not advanced far in its adaptation to it. Thus each one of us suffers more or less from atavistic frailties, which find their clearest expression in our constant complaints concerning the immeasurable complexity and growth of scientific materials. We ourselves and our children, and our children's children shall still enjoy through art, hours that are beautiful and perhaps great; for there will always be fields of human experience into which science has not yet penetrated and in which art will have undisputed sway. But to a future race which has conquered the science of psychology, many of the valued psychological dramas of today will seem as naïve and unsatisfactory as the first attempts that a child of four years makes at drawing.

But we must not dwell longer upon these questions, because there are others more fundamental which are to be answered. We have discussed these matters only that they might be applied to the problem with which we are dealing, namely, the gaining of a clear idea as to the direction in which the science of *biology*, which we consider specially here, will probably advance. In order that we should have the right to make any statement concerning this, it has been necessary to show that such a prophecy is possible. And now one more small preliminary consideration brings us directly to the problem.

Science is an organism which strives constantly for self-

preservation and development. It is therefore provided with organs of regulation, by which that which is useful is preserved and that which is harmful suppressed. It is possible for these organs to become active only when the processes themselves which are to be regulated come into activity. There is a certain delay in the working of each regulator. Thus it follows that science like every other self-regulating apparatus must necessarily undergo periodic variations from a middle point. This middle point is not necessarily unchangeable at all times. In our case it is undergoing a constant advance because science can only increase and not diminish in scope. Further there are here many sources of energy each with its own group of regulators; therefore we have to do with a number of superimposed phases which form a very complicated picture. For example, by the summation of many maxima or minima which in themselves are small we obtain a very great elevation or depression. We shall try to determine what part of the curve of depression or elevation science in general, and biology in particular now occupy.

Now one of the very influential components of these movements is plainly to be recognized. We have just passed through a period in which all sciences have been isolated, a period of *specialisation*, and we find ourselves in an epoch in which the *synthetic* factors in science are gaining a constantly increasing significance. Consider, ladies and gentlemen, what you have before you. In the lecture room of a *biological* institute there speaks to you on this important occasion, a man who is not only not a biologist, but who on the contrary has been expressly invited as the representative of a sister science. And further this man himself is the product of a synthesis of two neighboring sciences, namely physics and chemistry. Furthermore when this man seeks to bring to you the best which he can gather from his garden, he brings you no word of physics and chemistry, but rather thoughts which concern the triad, physics—chemistry—biology; and problems which include

these and still more distant sciences. This is not an accidental thing, but a genuine expression of the efforts which fill all our days. Everywhere the individual sciences seek a point of contact with one another; everywhere the investigator determines the value which his special results may have in the solving of the most general problems. In short all sciences are tending to be philosophical. Nowhere is this tendency towards fundamental explanations so great as in biology. A glance at the literature of biology shows with what ardent care the biologists strive to throw light upon the fundamental problems of their work.

Thus the biologists consider it of the greatest importance to learn the relation which their science holds to the neighboring sciences, especially to the inorganic natural sciences, chemistry and physics; and the conflict of opinions has become marked by the watchwords, *vitalism* and *mechanism*. As is true in all such instances, one great danger arises, namely, that a complex of many things of most diverse character, is often named according to one of many properties by which it may be determined. In fact we see that a well-known investigator calls himself a mechanist while the mechanists think of him as a vitalist. When I seek to deal in my own way with the problems which lie before us, I prefer to remain neutral in relation to the two parties. Much more is it my object from the broadest standpoint to arrive at a true estimate of the relations of the sciences which we are considering.

In an attempt to make a general classification of the sciences, one soon arrives at the conclusion that they do not stand *side by side*, but that they *include* one another in a reciprocal manner which may be represented incompletely by geometrical figures. Human experiences are above all the objects of study for every science. Each of them is made up of an unlimited number of component parts only a few of which according to the purpose of the science are taken into consideration. Thus the greatest number of experiences is included in that science which considers the

preservation and development. It is therefore provided with organs of regulation, by which that which is useful is preserved and that which is harmful suppressed. It is possible for these organs to become active only when the processes themselves which are to be regulated come into activity. There is a certain delay in the working of each regulator. Thus it follows that science like every other self-regulating apparatus must necessarily undergo periodic variations from a middle point. This middle point is not necessarily unchangeable at all times. In our case it is undergoing a constant advance because science can only increase and not diminish in scope. Further there are here many sources of energy each with its own group of regulators; therefore we have to do with a number of superimposed phases which form a very complicated picture. For example, by the summation of many maxima or minima which in themselves are small we obtain a very great elevation or depression. We shall try to determine what part of the curve of depression or elevation science in general, and biology in particular now occupy.

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smallest number of components. And it follows conversely that the smaller our range of choice in experiences is, the greater the number of components included by the sciences. Thus the science which from one point of view is the broadest is from the opposite standpoint the narrowest. The converse of this also is true.

In this wise you may note that on the one hand the theory of varieties (Mannigfaltigkeitslehre), by which I mean something of which mathematics or the theory of magnitudes is only a part, is the most comprehensive and the most narrow of all sciences, since it includes all experiences but considers them from only one standpoint (namely that each experience is an individual and separate thing). Psychology on the other hand is the narrowest and most comprehensive science because it considers only the phenomena which are connected with the existence of the human brain (or if one prefers it, with the human soul). Here however all possible components are taken into account. One may see at a glance that in the series of sciences with which the theory of varieties deals, each science pre-supposes the existence of that which precedes it in the series, but goes farther in that it comprehends new factors or new components of which the preceding science took no account. Its scope is therefore made narrower since it deals only with the subjects affected by these components. Mathematics thus has to do with varieties but only with those which possess magnitude. Geometry also deals with magnitudes, but only with those which have the properties of space. Physics treats of special objects only in so far as the various kinds of *energy* act upon them. Chemistry on the other hand deals with those physical objects which are distinguished from one another by qualitative differences with the exception of those differences due to the presence of different forms of energy. According to this system biology is that science which treats of those chemical objects which have a stationary condition of energy, that is, of nourishment and of reproduction. Finally, psychology

deals with life processes only in so far as they affect the functions of the mind. By this a practical and almost complete knowledge of the mental functions of man is arrived at, and this is almost the only thing of which we have certain knowledge.

It is scarcely necessary to say that this classification is arbitrary in that one may introduce numerous intermediate steps between those already given and in this way consider smaller differences. Thus one may interpose sociology and anthropology between biology and psychology, and physical chemistry between physics and chemistry, etc. I need not go farther into this matter. Of more importance perhaps would be the introduction between mathematics and geometry of chronological science, that is, the knowledge of the laws of *time* (which is not to be confounded with historical, geological or astronomical time). Still these considerations would carry us too far.

The most essential thing in connection with our problem, however, is that we should recognize plainly the general relations of biology. It includes all sciences from the theory of varieties to chemistry, that is, all biological phenomena are comprehended by the laws of these sciences. In exactly the same way all chemical phenomena are subject to the laws of mathematics and physics in so far as no chemical phenomenon will, if it is well founded, be contradicted by these laws. But the laws of mathematics and physics do not exhaust that which can be said concerning chemical phenomena; and the qualitative material differences which form the object of chemical study cannot be completely worked out by the means which these sciences afford. The cause of this lies in the fact that in chemistry we have a science of more manifold character than in the preceding sciences. It makes no difference whether a sphere of gold or one of carbon of equal size be charged with a hundred volts of electricity so long as we consider only the physical, that is, in this case, the electrical phenomena. But there is an irreconcilable difference, from

the chemical point of view, between *burning* a sphere of sulphur and an equally large sphere of carbon. In the same way chemical composition does not distinguish a living man from a dead man, but biologically there is a fundamental difference. The former is capable of nourishing and reproducing himself; the latter has not this power. You will perhaps here make some objections; but I do not believe that you will be able to make any essential change in this statement; at most it might be necessary to make the definition of life somewhat more accurate.

From this we obtain directly the answer to the much-discussed question as to whether the laws of chemistry and physics are sufficient to explain all biological phenomena. The answer must, from one point of view be yes, from another point of view no. We may say *yes* in so far as all biological phenomena lie within the realm of the possibilities which are given by these sciences. On the other hand, we must say *no* in so far as in this realm of possibilities a much greater complexity is attained by biological facts than it is possible to explain by physics and chemistry.

Perhaps the relationship of which we are speaking will become clearer if we inquire into the analogous relationship which exists between mathematics and physics. It is certain that all physical phenomena are considered under the conception of magnitude, and to this extent physics may be regarded as a part of mathematics. But it is just as sure that it is impossible to gain a complete knowledge of a physical phenomenon by the means afforded by mathematics alone. We can, for example, represent mathematically the physical processes which are connected with the passage of an electric current through a given conductor with that degree of accuracy which is attainable by the present methods of analysis. But we cannot represent mathematically the difference between this process and the conduction of heat through a similar body; for here we meet with new kinds of manifold characters which are not present in mathematics but are dealt with in the first place by physics.

Now since the mechanists look at this matter from one point of view and the vitalists from another, we have at the present day the remarkable phenomenon that in both camps there are highly distinguished and thoughtful investigators who apparently hold opposite views, while there can be no more than one true standpoint; and the members of both camps are known to us as earnest and trustworthy seekers for the truth.

Undoubtedly these general considerations have their value in connection with problems with which we are dealing only in the thorough investigation of the components which serve to distinguish biological objects from chemical objects. We sum up this distinction ordinarily in the word *life*. If we inquire into the parts of this concept which may be recognized and measured we find the following to be true: Living beings in the first place are not stable, but on the contrary are stationary structures. Rapid changes take place in them of such a nature that gain and loss counterbalance one another so that the whole system experiences only slow changes (which are almost all periodic). Since all physical changes may be represented as displacements of different kinds of energy in space and time living organisms are characterized by the fact they keep their condition of energy approximately constant in its nature and amount, while a constant current of various energies flows through their bodies. According to the general laws of energy this can take place only in such a way that the living organism takes up energy of a higher potential and gives it off at a lower potential. In the meantime the energy has been used for those transformations which make up the various activities of life, namely, movements, the production of heat, reproduction, etc.

These characteristics are common not only to living organisms but also to many inorganic structures. A burning candle whose wick is supplied with melted fat at the same rate at which it burns, or a benzine motor which regulates its benzine supply by means of the ball governor

in such a way that its velocity remains constant, has exactly the same property as a living organism. Thus we are in the habit of speaking of the "flame of life" or of the "machines of our bodies," but we do not regard these things as living organisms because their existence is not self-maintaining. When the fat is used up, or the benzine is exhausted, the flame goes out and the motor comes to a standstill, for the former cannot produce new fat nor can the latter obtain new benzine.

Still it is possible to conceive of a further regulator which might pump new benzine from a tank into the reservoir of the motor when that which is already there becomes exhausted. But in the end this also would be used up or some essential part of the machine might become broken so that the stopping of the machine would become inevitable. In order to maintain itself, or others of the same kind, the machine must in the first place be able to go where it can find new benzine, or, on the other hand, it must be able to replace by its own efforts the parts which have been destroyed; or it must, before it is completely broken, be able by itself to create a new machine which will carry on its work. *If such a machine existed we would be obliged to regard it as a living organism.*

Such a conclusion will perhaps seem to you arbitrary. Still among others one very able investigator has expressed the opinion that even if a structure with all the properties and functions of a certain organism could be artificially produced this would nevertheless not be a true living organism. With reference to this it is only necessary to ask the question, how it would be possible to distinguish a true living organism from an artificial one of the same character, assuming that such an organism could be produced. According to the assumption, both organisms are identical in all their properties, that is, in all those which can be recognized. And two things which can not be distinguished from one another must be considered as fundamentally the same.

It will be found that this conclusion is by no means so arbitrary as at first appears. Our conceptions are formed by gathering together the common points of many phenomena and neglecting those factors which are not common to all. In *stable* chemical structures the conception of chemical *substances* includes those objects with identical specific properties, and we are able to form this conception because we can find or produce the individual substances, for example, sulphur, under the most diverse circumstances, and they show always the same specific properties. It is much more difficult to form such conceptions concerning structures in which chemical *changes* are taking place. In order that such structures may be the subject of the formation of a concept they must appear stable at least externally since otherwise we should have no means at all of identification. Since, according to the definition, they are not *stable* they must at least be *stationary*, but even stationary structures will not lead us to the formation of a concept if they do not always appear in the same form. Structures of this sort which are *physically* stationary are rivers, clouds, and waves; they are essentially characterized by definite special formations for the existence of which conditions are easily and frequently brought together. Structures which are *chemically* stationary occur very much more rarely because the conditions are more difficult to bring about. The only instance which I can present to you is that of *flame*, for the existence of which there are necessary the following factors, namely, the almost omnipresent oxygen, the widespread remains of plants, and the presence of a temperature of about 400° or 500°. And this simple group of conditions very seldom occurs spontaneously, that is, without the intervention of human beings.

It is evident, therefore, that the voluntary formation of such structures as possess in addition to their stationary properties also the power of self-maintenance, that is, the capacity for seeking out the necessary sources of energy must be an extremely rare phenomenon; and only when

such a structure is possessed of the property of *reproducing* its kind will the possibility arise of its coming so often under our observation that we may be able to form a corresponding concept. From this point of view the condition of affairs seems to be as follows: These considerations teach us nothing concerning the manner in which the organism may be constructed; but they do indeed teach us that we would never have arrived at the conception of the organism as a stationary chemical structure if this structure did not possess in a special sense the properties of assimilation and reproduction. These properties are those which are always met with in the stationary chemical structures which we call living organisms. They form the new and specific features of biology as opposed to chemistry. In this respect the vitalists are entirely correct.

When, however, according to this point of view it is maintained that we "consequently" shall never be able to explain life, there exists a confusion between a problem of scientific classification and one of experimental investigation. The explanation of this lies here, as everywhere, in the recognition of real relationships between different series of phenomena. *One* chemical explanation of life we have already discussed. There can be no doubt in the minds of any of us that life without chemical processes in which free energy is available is inconceivable. That which is lacking is the complete analysis of the individual chemical processes of this sort which take place in the living organism. In a general way we know many of these processes, such as the phenomena of oxidation in the tissues, many of the processes of digestion in the intestinal canal, etc. Most of them, however, are still unknown to us. It must as yet remain doubtful whether or not it would be possible to *create* such an organism even if we were possessed of a knowledge of all these processes. We have conceived of and explained many things without having been able to *make* them, and whether the living organism belongs to this group or to the other class of those structures which we can

manufacture, can be determined only during a future period of study.

In order to make more clear what I mean I shall call your attention to an illustration. In a space in which there is contained no electricity we can at any time create it; we are able, in other words, to change other forms of energy into electric so that it will include its two factors electrical quantity and electrical potential. On the other hand, we cannot in the same way produce the energy of gravitation but only make it smaller or greater by placing heavy bodies near to, or remote from one another. The cause of this is easy to understand. Electrical quantities always exist in positive and negative forms in equal parts so that their algebraic sum is constantly *zero*. In consequence of this it is possible to produce any desired quantity of electricity without violation of the law of the conservation of capacity, since its total quantity remains zero. The corresponding factor in the energy of gravitation, however, is proportional to the mass and has therefore necessarily a positive value which can be created or changed just as little as the mass itself. At the present time it cannot be predicted with certainty whether or not, in the complete analysis of life, such factors will be discovered which cannot be created. From the circumstance, however, that life can be voluntarily destroyed it seems to me fairly probable that its voluntary creation is made impossible only by techincal and not fundamental difficulties.

What, then, are these difficulties? This question has already been often answered. The difficulties consist in the fact that the most simple organism is a very complex structure, in which numerous different reactions go on side by side, so that they afford one another mutual support in the vital purpose of self-maintenance, etc. For this purpose many things are necessary, especially that the velocities of these reactions should correspond with one another so that they may act together to accomplish the end in view. A machine would break itself to pieces if the movements of

all its parts did not succeed one another at equal periods and at the right time. In this instance the problem is solved by having the different parts bound in a fixed relation with one another so that no other motions except those which are intended are possible. Such compulsory combinations of chemical processes are perhaps also present in the living organism; they occur, for example, if in the alimentary canal the materials provided for the necessary reactions are secreted in different parts of the canal and become mixed with previously prepared chyle by being moved along with it in one direction; but with regard to an individual cell such a mechanical solution of the problem is not very probable. Moreover, in the living organism the same task is usually accomplished in very different ways according to conditions.

The further means of accomplishing the same purpose is the *regulation of the velocities of reaction* by means of catalysers or enzymes. The occurrence of such substances in the various parts of the organism was recognized by Berzelius. He, and later on Ludwig, expressed the opinion that the enzymes play a general and very important rôle in the organism. Later investigations have confirmed and extended this idea. There seem to be in reality only a few tissues in which enzymes are not present, and usually a large number of them appear together. While these older investigators in the light of the scientific knowledge of that time, ascribed to enzymes the property of actually causing reactions and consequently of creating certain materials, we are now in a position to broaden this conception and make it more comprehensive since we know that the enzymes have also the power of regulating the *velocities* of the reactions. That there may exist in a sense a fixed connection between the action, enzymes is shown, for example, in the later investigations in reference to the germination of seeds. In this process there appear in succession the enzymes of the solution of starch, of oxidation, and of assimilation. The sequence of their appearance, their

quantity, and the place in which they appear, are such that the process of development takes place everywhere in the young plant regularly and purposefully.

In this connection there arises a problem of fundamental importance which formerly has not been placed in the realm of biology, since the necessary foundation of general chemistry has been acquired only in late years, namely, the problem of the *time sequence* of processes in the organism. The spatial sequence has been shown to us by the microscope, and I must describe to you, at least the rôle which this instrument has played. Biology has for a long time concerned itself with certain problems of time relationship, especially those connected with embryology. But microscopy in relation to time, the analysis of that which takes place at each instant during life, especially the time microscopy of chemical processes, presents a problem for the solution of which very little evidence has been presented. It is, however, a problem which must be solved if we wish to go earnestly into the solution of the deeper problems which life presents to us.

Where and how these problems are to be attacked will probably be better known by you than by myself. Probably the best method will be to approach them from the most diverse points of view since as a whole they are of inconceivable complexity. Since I myself have never concerned myself with the problems of biology I cannot venture to offer suggestions to the workers in that science. The only thing which I can do is to indicate the general points of view which come to light in the consideration of the general study of science. The problem lying before us of the coördination of a large number of different phenomena to form a stationary unit scarcely existed in the sciences developed before chemistry; and when such a combination was made it was mainly by means of addition or superposition, that is, the whole series of phenomena related to the point in question was considered as the sum of the individual factors. In this way each of these factors played its

own part as though the others were not present. Thus sound waves cross one another in a most complex way without becoming confused, and in the same way two or three or more rows of waves may play over the surface of the sea in different directions and each one retains its own arrangement and its own characteristics. But here one sees already the limitations for the applications of this principle. When a large wave breaks the smaller ones vanish in the disturbance of the surface and are never seen again. This is due to the fact that the waves are stable structures only up to a certain limit; if this limit is overstepped the forms of energy which are present are converted into other forms, and the principle of superposition no longer gives a satisfactory explanation of what happens.

This reaction of which we have just spoken is universally present in organisms. Small changes in one factor of a given condition will bring about proportionately small changes in other factors, but only in the rarest instances will a superposition be evident. When one allows a string to vibrate, a change in temperature will bring about a change of the pitch, but this is simply due to a change in the elasticity of the string, and in the determination of this factor lies the solution of the problem. If the temperature of an organism be raised there occurs not only the corresponding change in the physical properties of the tissues, but at the same time changes are brought about in the velocity of the reactions of all chemical processes which take place in the organism, and indeed each reaction is influenced in a different way. By this means the relation which these reactions hold to one another is changed, and it may happen that through slight influences of this sort in any one place the limit is overstepped within which the organism remains a stationary structure. In such a case death results. It seems to me that there is no doubt that, as I suggested many years ago, the remarkably accurate and finely adjusted self-regulation of the higher mammals, by which they become converted into thermostats of

unusual constancy, has its origin in the necessity of keeping constant the relation which exists between the velocities of the chemical reactions, in order that the processes of life may take a normal course. In this *problem of co-ordination* it seems to me that the most important side of biology lies, namely, the part which has to do with time relations. Here also are present the phenomena which require the formation of concepts of a new sort for their intellectual conquest; concepts which are not necessary in the more general sciences. In these fields, biology will rule by itself, though still not independently of chemistry and physics. It must exert its influence on the other hand, within the limits of empirical possibility laid down by the latter sciences. These limits and conditions, however, the biologist must know and respect, if he wishes to solve his problem. He must be familiar with the ways and means of general chemistry and physics in order to gain an idea of the ways and means of the living organism. This leads us again to the main question on account of which we have undertaken this whole discussion, namely the question: How does the wind now blow upon the sea of science? The answer is as we have already said, towards *synthesis*. The fairest and richest results are to be expected in that place where the various sciences reach out towards one another for mutual help, and you see therefore, how it is that I have been able to predict for our ship a most fortunate voyage. The course which seemed best when observed from the highest standpoint to which I could attain is the same as that which the pilot of this ship has already held for many years. He needs only to steer his accustomed course in order to gain the best which one may hope for. Thus it only remains for us to wish him and his crew a pleasant journey.

THE LIMITATIONS OF BIOLOGICAL RESEARCH.*

JACQUES LOEB.

The opening of a new laboratory which is preëminently intended for scientific research is an event in which everybody may rejoice and which no one need regret; for it is the function of all scientific research to increase the possibility and value of life. Not only the University but the whole community may feel grateful to those whose generosity has made the laboratory possible. I may be pardoned for adding an expression of my personal gratitude to President Wheeler and Mr. Howard who have shown the greatest consideration for my wishes in regard to the building of the laboratory. I also wish to express my thanks to my colleagues Mr. Fischer and Mr. Cory for the help I have received from them. Last, but not least, our thanks are due to Professor Ostwald. The fact that he has come here to dedicate a new laboratory is perhaps the greatest distinction which could have been bestowed upon the University by the scientific world. But his presence here today means more to us than this. It is being recognized that the economic, hygienic and intellectual progress of a nation depends directly or indirectly upon the results of scientific research. American universities are just taking their first steps towards giving research that

* Address delivered at the dedication of the Rudolph Spreckels Physiological Laboratory of the University of California, August 20, 1903.

place which it has occupied for several generations in European and especially in German universities. If one of the recognized leaders of scientific thought and research in the Old World is willing to interrupt his work and participate in the inauguration of a laboratory on the Pacific Coast, we may be sure that the new departure of American universities has won for this country the sympathy of the best and therefore the real representatives of the European nations.

It is customary to indicate on an occasion like this the general direction and tendencies of the work which will be carried on. I need not dwell upon the importance of physical chemistry for physiological problems as I have often discussed this before. It is realized by all biologists that the source of energy in life phenomena is chemical, while many of the manifestations of life are physical in character. From this alone it is evident that physical chemistry must form the foundation of biology.

It is clear that the more fundamental the problems are which a laboratory undertakes the more it may hope to accomplish, but it is also true that at each period the number of tasks which might be undertaken successfully is limited. What we call the explanation of a phenomenon is according to Mach the possibility of presenting it as an unequivocal function of those variables upon which it depends. Each generation can hope to solve successfully only those scientific problems whose variables it adequately knows and controls.

One of the fundamental problems of biology is to find a definite answer to the question whether or not it is possible to make living matter out of dead matter. No one has thus far succeeded in transforming dead matter into living matter, and no one has thus far observed the spontaneous generation of an organism in nature. In consequence of this fact Arrhenius assumes that living matter has eternally existed, and has been carried through the universe from star to star in the shape of extremely minute particles, such

as spores, at or below the limit of microscopic visibility. He has calculated that electrical charges of these particles and radiation pressure suffice to bring about a transmission of living particles from one star to another in a comparatively short time. On the other hand, however, we are warned by a number of reasons not to be too hasty in assuming the impossibility of abiogenesis. As far as we know the substances found in living organisms are chemically well characterized and can be obtained outside of living organisms. Moreover, the growth of an animal or plant from a microscopic germ to its adult state depends upon a constant transformation of dead matter into living matter. Did this transformation not occur constantly in all living beings no living organism would be left today. As far as the dynamics of this transformation of dead matter into living matter inside an organism is concerned we know that no other specific agencies are involved than enzymes. The action of enzymes, however, does not seem to differ in any way from the action of inorganic catalytic agencies. I do not think it too bold to prophesy that the general physico-chemical character of these enzymes will sooner or later be cleared up. As regards the oxidizing enzymes the goal seems to be already in sight.

In going over in detail all the features of life phenomena we find that many of them can either be imitated in inorganic nature in all their details, or can be controlled unequivocally by physical or chemical means. In fact this is the case to so great an extent that it almost causes surprise that the experimental transformation of dead matter into living has not been accomplished. But we must consider the fact that the peculiar complex of physical conditions which we call the structure of living organisms is absolutely essential for life phenomena. If an organ, a brain for example, be ground to a pulp its function ceases. When the kidney is ground to a pulp it loses the power of transforming benzoic acid and glycocoll into hippuric acid, provided all the cells are destroyed. From this the conclu-

sion was drawn that possibly all the synthetical processes of an organism depend upon the normal structure of the tissues. This certainly goes too far, for we now know that soluble enzymes which can be extracted from the tissues, for example lipase, not only accelerate hydrolytic but also synthetical processes. But it can not be denied that the physico-chemical peculiarities which we call the structure of the living tissue form an essential part in the complex conditions which determine life phenomena. In regard to the question of abiogenesis the biologist is therefore placed before two possibilities. Biologists will either succeed through a series of discoveries in transforming dead matter into living matter, or they will finally discover that there is as definite a discontinuity between dead matter and living matter as there is between two chemical elements.

Another problem of transformation faces the modern biologist, namely, that of transforming one species into another. If living organisms have arisen from dead matter the first forms of living matter must have been simple in structure, and perhaps not more complicated than spores. If living germs are as old as cosmic matter the transportation of germs from star to star is only imaginable if the germs were extremely small and consequently simple in structure. In either case it is necessary to assume that the present fauna and flora of the earth must have developed from structures of no higher degree of differentiation than, for example, spores. If an investigator were asked today which he considered more difficult, to make a highly organized plant or animal from the spores of a fungus, or to make a spore from dead matter, I am afraid he would hesitate to decide. Yet a majority of investigators have been convinced since the days of Lamarck and Darwin that such an evolution must have occurred. We are better off in regard to our observations concerning evolution than in the question of abiogenesis, for there can be no doubt that hereditary transformations, within narrow limits at least, have occurred. I need only

mention the positive observations of DeVries. But all the variations which have thus far actually been observed are extremely slight, so that it is still difficult to grasp an evolution from cosmic spores or protoplasmic material of the simplest structure into such highly developed machines as human beings. As far as I am aware no one has yet found a method of bringing about a rapid variation in animals or plants. I am inclined to believe that this failure is at least partly due to the existence of mechanisms of regulation. We know that our body possesses automatic regulators to keep our temperature constant, that there are automatic regulators for keeping the concentration of sugar in the blood tolerably constant, etc. Any too sudden and extensive change in an organism probably interferes with these automatic mechanisms, and therefore leads to the destruction of the organism. We again meet with two possibilities: we shall either succeed by a series of continued slight changes in one and the same form in bringing about a large transformation from the original form, or we shall obtain the result that in each form the possibility of evolution is limited, and that, at a certain point, the constancy of a species is reached. Either result if guaranteed by adequate observations will be a welcome discovery.

Before closing allow me to make one additional remark. It is quite common to find that even scientists are inclined to assume that the restrictions or limitations to research in biology are greater than, or of a different order from those in the field of physics or chemistry. This is not true so long as we treat biological problems in the same unbiassed and unprejudiced way in which we deal with the problems of physics and chemistry. The alchemists tried to solve the problem of perpetual motion and of making gold. No one, however, would say that the physicist or chemist is limited in his search for truth because perpetual motion is impossible and the chemical elements are constant. On the contrary, it is fully recognized that the discovery of such constants as the quantity of energy of a closed system or

the chemical elements were the most fertile discoveries ever made, and, in fact, are among the pillars on which not only modern physics, chemistry and biology, but indirectly our whole modern civilization rests. Why should we change our attitude when we leave the field of biology, and why should we consider it a restriction or limitation of knowledge if it should turn out—which is far from certain, however,—that it is no more possible to transform dead matter into living matter than to transform copper into gold?

UNIVERSITY RECORD.

VICTOR HENDERSON.

IN MEMORIAM—PRESIDENT MARTIN KELLOGG.

The death of President Martin Kellogg closes the first chapter in the history of the University of California. He alone of the Academic Senate had served the University from its beginning. For forty-four years his life was consecrated to the up-building of the University whose spiritual foundation-stones he had helped to lay. Only one man was numbered before him on the academic roll—Henry Durant, first President of the University, and it was on the same day that President Durant was chosen Professor of the Latin and Greek languages—August 13, 1859—that Dr. Kellogg was appointed Professor of Mathematics in the old College of California.

The best ideals and traditions of New England were embodied in President Kellogg's mind and heart and life. Born in Vernon, Connecticut, on March 15, 1828, he graduated from Yale in 1850 and received the degree of A.M. in 1853. He was married on September 3, 1863, to Louise Wells Brockway, who survives him. Early in the American occupation of California he came to preach the gospel in the new land where for half a century he was to toil mightily for all good things. It was while serving as pastor of the Congregational Church at Grass Valley that he was called upon to share in the founding of the College of California.

Upon the chartering of the University of California by the State, Dr. Kellogg became the earliest member of the Academic Senate, for on September 1, 1868, he was made Professor of Ancient Languages. The Classical Department was divided in 1876, and he became Professor of the Latin Language and Literature. For fifteen years Dr. Kellogg was called upon for constant administrative work in the capacity of Dean. He first became executive head of the University in 1888, when, during the interval between the resignation of President William T. Reid and the coming of President Edward S. Holden, he served as Chairman of the Academic Faculty. Upon the resignation of President Horace Davis in 1890, the Academic Senate chose Professor Kellogg as its temporary President. The Regents concurred in this action and assigned to him the duties of President of the University with a seat in the Board. On January 24, 1893, he was formally elected President and on March 23, 1893—Charter Day—he was inaugurated. In the spring of that year he was summoned by Yale University to receive the degree of LL.D. In 1899 Dr. Kellogg resigned the Presidency. After a year's journey around the world by way of Japan, Ceylon, Egypt, and Europe, he returned to Berkeley as Professor Emeritus of Latin. Throughout the years since then he has taught to new generations of students his well-loved Cicero, Horace and . Quintilian. Through forty-four years of service his thought and faith and purpose have been wrought into the very substance of the University.

IN MEMORIAM—PROFESSOR JOHN HENRY DYE.

John Henry Dye, Assistant Professor of Civil Engineering, not for long a member of the University, but quickly entrenched in its honor and affections, died in Oakland on April 29, 1903, after several months of illness. Professor Dye was born in Marion, Iowa, December 18, 1871. Up to his fourteenth year he was a school-boy in Geneva, Switzerland; in 1890 he graduated from the High School

in Washington, D. C.; and in 1895 he received the degree of Bachelor of Science in Civil Engineering from the University of Michigan. As an undergraduate he was one of the best athletes of his time, and his personal popularity was attested by his election to the presidency of the Engineering Society of the University of Michigan.

The King of Corea summoned Mr. Dye, immediately upon his graduation, to become the royal Civil Engineer. He joined in Seoul his father, a distinguished soldier—William McE. Dye, Brevet Brigadier-General in the United States Army, a graduate of the United States Military Academy, throughout the Civil War Colonel of the Twentieth Regiment of Iowa Volunteers, and four times brevetted for gallantry. After serving as Colonel of Staff in the Khedive's Army throughout the Abyssinian campaign General Dye had been called to Seoul by the King of Corea to reorganize the military forces of the kingdom as General-in-Chief of the Corean army. As Civil Engineer to the King of Corea Professor Dye built additions to the royal palace, bridges, roads, and drainage canals, and surveyed a railway from Seoul to its seaport of Chemulpo. The life of father and son was full of romantic circumstance. On one occasion these two brave men, aided only by a remnant of the company of household servants, withstood for two weeks a siege of the palace by a mob of revolutionists.

After the death of General Dye in 1899, Professor Dye refused a call to the faculty of the University of Michigan, and went instead to the University of Nevada to take charge of its Department of University Extension in Mining, at Virginia City. He accepted a call to the University of California in July, 1901. On August 1, 1901, at Holly Springs, Mississippi, he was married to Miss Pearl Walter, the daughter of Mr. Harvey W. Walter of Mississippi.

Here Professor Dye had charge of the field work in surveying and of the summer school of Civil Engineering. He gave instruction also in sanitary, water supply, and

municipal engineering, and in railway engineering office practice. During his stay in Berkeley he received a number of calls to other universities and to scientific posts in the service of the United States, but he preferred to stay here and to develop the possibilities of his California position.

THE GREEK THEATRE.

Since the class of '94 established the precedent by its "Vehmgericht," it has been annual custom for the graduating class to present an open-air spectacle on Class Day afternoon in the fine natural amphitheatre long known, from its discoverer, as "Ben Weed's Amphitheatre," hidden in the eucalyptus grove against the lower slopes of the Berkeley hills. The great need of an auditorium for academic festivals suggested the erection of tiers of seats on the natural slopes. Sketches of several plans for such a development of the rarely favorable site were shown to Mr. William R. Hearst. Mr. Hearst at once chose the finest and most ambitious plan and expressed his willingness to bear all the necessary expense—some forty thousand dollars. Professor John Galen Howard had conceived the happy idea of realizing the possibilities of the place by building there an open-air theatre, modeled after such a Dionysion as that of Epidaurus, a type more beautiful in form and for seeing and hearing better than any theatre man has yet devised, and developed by the Greeks for just such a climate and just such natural surroundings as those of the University of California. Under Mr. Howard's hand has risen a noble structure, satisfying in its dignity and restful charm. While it is archaeologically correct, and while in its proportions it resembles the theatre at Epidaurus, it is in no way a slavish imitation of any Greek original, but a genuine response to need, sympathetic no less with nature than with tradition.

Overhung by a grove of lofty eucalyptus trees, the theatre leans against the high hill slope. The auditorium is semicircular in form, two hundred and fifty-four feet in

diameter, and divided into two concentric series or tiers of seats. The first series is arranged about a level circle, fifty feet in diameter and six feet below the stage, which corresponds to the space anciently devoted to the chorus. Beyond this circle the succeeding rows of seats rise gradually until the stage level is reached at a circle marked architecturally by a broad aisle termed by the Greeks the diazoma. Beyond the low wall which protects the outer side of the diazoma, the seats rise up more steeply, approximately at an angle of thirty degrees, to the outer limit of the theater. In this "theatron" seven thousand spectators can be seated comfortably, and each will fancy his own ledge best of all for seeing and hearing.

The auditorium is fronted on the west by a magnificent stage, a hundred and thirty-three feet wide and twenty-eight feet deep, entirely open toward the theatron, but closed in on the other three sides by a wall forty-two feet in height. This wall—the ancient skene—is enriched by a complete classic order of lofty Doric columns, with stylobate and entablature. The ends of the side-walls toward the auditorium form two massive pylons. Five openings pierce the stage walls. In the center is the "royal door" of the ancients, flanked by minor doors at right and left, and in the return walls at either end of the stage are massive doorways to the "strangers' house."

The entire building is of Portland cement concrete. The final detail of the stage wall, including mouldings, capitals, metopes and triglyphs, cornices and architraves, has been executed by hand in cement.

COMMENCEMENT WEEK.

The new Greek Theatre was used for the first time, though then not more than one-third completed, in Commencement Week of 1903, for the Class Day spectacle and for the Commencement exercises. The theatre even in its unfinished state proved most successful acoustically, for convenience in handling a vast crowd, and for unobstructed

hearing and seeing for every member of the audience. The formal dedication took the form of a dramatic festival of several days duration.*

The Commencement Address was delivered on May sixteenth by Theodore Roosevelt, President of the United States. After being admitted to the fellowship of the University as Doctor of Laws, President Roosevelt delivered a high appeal to right living, private and civic.† The military commissions were awarded by Governor George C. Pardee, '79, and the medal conferred upon Miss Mary Edith McGrew of the College of Letters. The student speakers were Robert Sibley of the College of Mechanics; Allan Pomeroy Matthew of the College of Letters; and Jesse Henry Steinhart, '01, of the Hastings College of the Law.

The participation of the earliest living graduate of the University, Rev. Albert Franklin Lyle, '64, was a notable feature of Commencement week. Mr. Lyle officiated as chaplain at Commencement, he spoke at the annual alumni luncheon in the Harmon Gymnasium, immediately after the Commencement Exercises, and he delivered an address at the annual reception of the Alumni Association at the Mark Hopkins Institute of Art.

The Annual Public Address before the Phi Beta Kappa Society was delivered by Professor H. Morse Stephens, his subject being "Historic Atmosphere;" the society just before the address received Professor Stephens into membership, as also Professor Charles Montague Bakewell, '89, and Professor Adolph Caspar Miller, '87,—the only alumni thus honored save Dr. Herbert Charles Moffitt, '89, so chosen two years ago. The Baccalaureate Sermon was preached by Frederick W. Clampett, Rector of Trinity Episcopal Church in San Francisco. The annual French Lectures, provided by the kindness of Mr. James H. Hyde

* The addresses at the opening of the dedication ceremonies and an account of the dramatic festival will appear in the next number of the *Chronicle*.

† President Roosevelt's address will be found on another page of this number of the *Chronicle*.

and Mr. Charles B. Alexander of New York and Prince A. Poniatowski of San Francisco, were delivered by Monsieur Léopold Mabilleau of Paris, Director of the Musée Sociale.

DEDICATION OF THE PHYSIOLOGICAL LABORATORY.

The Spreckels Physiological Laboratory, the gift of Mr. Rudolph Spreckels of San Francisco, was dedicated on August 19th with public exercises in the Harmon Gymnasium. The equipment of the building was given by Dr. M. Herzstein and Mr. Spreckels, and Mrs. William H. Crocker provided the nucleus of a physiological library. The Dedication Address, delivered by Professor Wilhelm Ostwald of the University of Leipzig, as also the address given by Professor Jacques Loeb, head of the department of Physiology, will be found elsewhere in this number. After the exercises the newbuilding was thrown open for inspection.

The distinguished chemist who had come so far to share in the inauguration of the new laboratory, was made heartily welcome during his stay in California. Dinners or lunches were given in his honor by Dr. Herzstein, by the University Club of San Francisco, by the California Section of the American Chemical Society, by President Wheeler, and by Professor Loeb. A reception was given for him by the Faculty Club and he was elected to honorary membership; he was entertained at Stanford University, he was the guest of Mrs. Hearst at the Hacienda, and upon the eve of his departure the Academic Senate assembled in special session and adopted an address in expression of appreciation of his coming.

Professor Bernard Moses was welcomed home at the University Meeting of August twenty-eighth, after three years of absence from his chair of History and Political Science and three years of fruitful public service as a member of the United States Philippine Commission. The same University Meeting was a farewell to Professor Kendrick Charles Babcock, who, after seven years of high service to the University as teacher, as school examiner, and as wise coun-

sellor, fellow-worker, and friend of the students, goes forth to become President of the University of Arizona. Another heavy loss to the Department of History is the resignation of Dr. Gaillard T. Lapsley, Assistant Professor of History, who in May accepted a call to the University of Pennsylvania. Mr. Robert Sibley, '03, on September 15 resigned from the Department of Electrical Engineering to become Professor of Mechanical Engineering and head of the department in the University of Montana.

SUMMER SESSION.

The Summer Session of 1903, from June twenty-fifth to August fifth, brought together 859 students, of whom 46.56 per cent. were men and 53.44 per cent. women. The enrollment was greater by twenty-nine than for the Summer Session of 1902. The average age of the students was 26.8 years, but the limits were sixteen and seventy-six years. Of the 859 students, 163 were under twenty-one years of age. Sixty-eight were graduates of the University of California, twenty-five of Stanford, ninety-three of other colleges, and ninety-three of normal schools, while of the rest three hundred and ninety-eight were graduates of High schools and twenty-five of academies.

The occupations represented were most various. There were no less than three hundred and sixty-nine teachers enrolled. There were sixteen superintendents of schools, four stenographers, three collectors, surveyors, housekeepers, and reporters, two clergymen, miners, civil engineers, and real estate agents; a playwright, an editor, a mail-carrier, a railroad fireman, an osteopathic practitioner, a draughtsman, a steam engineer, a violin teacher, a pianist, a lawyer, a milliner, a photographer, a farmer, a laundry agent, a cattle man, an insurance agent, a pharmacist, a trained nurse, an electrician, a physician, a millman, a boarding-house keeper, an entomologist, and a college president. There were two hundred and sixty-four students of the University of California, sixty-one Stanford students,

eleven students from other colleges, and twenty-seven students from high schools.

Of the 859 summer students, 759 gave California as their residence; six were registered from other countries, and ninety-four from American states other than California. Save for California the states most numerously represented were Washington with eighteen, Oregon with fifteen, Utah with twelve, Arizona with nine, Idaho with seven, Colorado with five. There were four each from Texas and Hawaii, three each from Illinois and New Mexico, two from Iowa, Missouri, Nevada, and Michigan, and one apiece from Ohio, New York, Kentucky, Minnesota, Kansas, and Massachusetts. Of the foreign-comers, three were from Japan and one each from Canada, Germany, and Mexico.

Of the 759 residents of California, 314 were from Alameda county, 115 from San Francisco, sixty-two from Santa Clara county, forty-four from Los Angeles county, eighteen from Fresno, fifteen from Tehama, fourteen from San Bernardino, thirteen from San Diego, eleven each from Solano and Santa Barbara, and eight from Tulare and Merced. Only nine of the fifty-four California counties were unrepresented—Alpine, Del Norte, Eldorado, Lake, Lassen, Modoc, Plumas, Sutter, and Tuolumne.

The Summer Session programme was carried out as announced, save that Mr. Gifford Pinchot, Forester of the United States Department of Agriculture, was unable to reach California before the close of the Summer Session, and so gave his promised lectures in September instead of before a summer audience, and save for the much-regretted withdrawal of Professor Angell, who was forced by illness to give up his work. His courses were carried to completion by Professor Stratton.

Dean Richardson arranged a number of University Meetings, public lectures, excursions, and opportunities for recreation, which added much to the pleasure and profit of the summer students. The Faculty Club played a very useful part in bringing visiting and permanent members of the faculty into pleasant companionship.

Four outposts of the Summer Session were the Marine Biological Laboratory at San Diego, under the direction of Professor Ritter; the Summer School of Forestry, conducted at Idyllwild near San Jacinto by Professor Willis L. Jepson and Professor A. V. Stubenrauch, with the assistance of Mr. T. P. Lukens of Pasadena; the summer lectures given by Dean Richardson, Professor Irving Stringham, Professor W. S. Ferguson, and Professor Chauncey W. Wells at the College of Notre Dame in San Francisco for the teachers of the various branches of that institution; and the Summer School of Surveying near Monterey.

Professor Ritter was especially gratified by the outcome of the summer's work at San Diego. The natural conditions were found unusually favorable. No undergraduate instruction was offered, but attention was concentrated upon research, with study of the plankton as the special object. Professor William E. Ritter investigated the tunicata and enteropneusta, Professor C. A. Kofoid and Mr. John F. Bovard worked upon the protozoa, Dr. Harry B. Torrey on the coelenterata, Mr. Calvin O. Esterly on the copepoda; Dr. Anton J. Carlson of Stanford on the comparative physiology of the invertebrate heart; Professor B. M. Davis of the Los Angeles Normal School on the flotation of marine organisms; Miss Marian Hubbard on the protochordates, and Miss Margaret Henderson on the jelly-fishes and polyps, while Mr. H. M. Evans carried on hydrographic observations.

This summer research work in zoölogy was made possible by the generous aid of Mr. E. W. Scripps, Miss Ellen Scripps, Mr. Homer H. Peters, Mr. E. S. Babcock and the Coronado Beach Company, Mrs. Fannie Keating, Mr. U. S Grant, Jr., Mr. George W. Marston, Mr. W. E. Clayton and the San Diego Electric Railway Company, Mr. W. H. Putnam, Dr. Fred Baker, Mr. H. P. Wood, and the San Diego Chamber of Commerce. The Chamber of Commerce has offered to provide funds for the continuation of the work during the coming Christmas vacation.

RHODES SCHOLARSHIPS.

The terms for the award of the Rhodes Scholarships, as now announced by the Rhodes Trustees, provide that the Rhodes Scholarships for California shall be administered by a committee consisting of President Wheeler as chairman, President Jordan, and Professor E. C. Norton, Dean of Pomona College. The scholarships are to be awarded in rotation, in proportion to the number of students of Greek, to students of California, of Stanford, and of the smaller colleges of the State considered as a group. The recommendations made to the Rhodes Trustees by the Pacific Coast conference held at the time of Principal Parkin's visit correspond closely to the plan eventually adopted by the Rhodes Trustees. Candidates must be unmarried and not over twenty-five years of age; they must have reached at least the end of the sophomore year in some recognized university or college, and they must be prepared to pass the Oxford admission examination known as Responsions. This would imply, ordinarily, that the student must have continued the study of Greek throughout his sophomore year. Perfect health and fine physique are requirements for candidature.

All California candidates are expected, during the month of January, 1904, to notify President Wheeler, as the chairman of the committee of selection, of their intention to present themselves for examination. At some time during the spring examinations will be offered from questions forwarded by examiners appointed by the Rhodes Trustees. These examination papers will be sent to the Rhodes Trustees for revision. A list of those who have successfully passed the test will as soon as possible thereafter be furnished to the California committee and from this list the local committee will choose the Rhodes scholars. The decision of this committee of selection as to eligibility is final. The examination held before the choice is made is not competitive, but is intended only to give assurance that all candidates are fully qualified to enter on the course of study at Oxford.